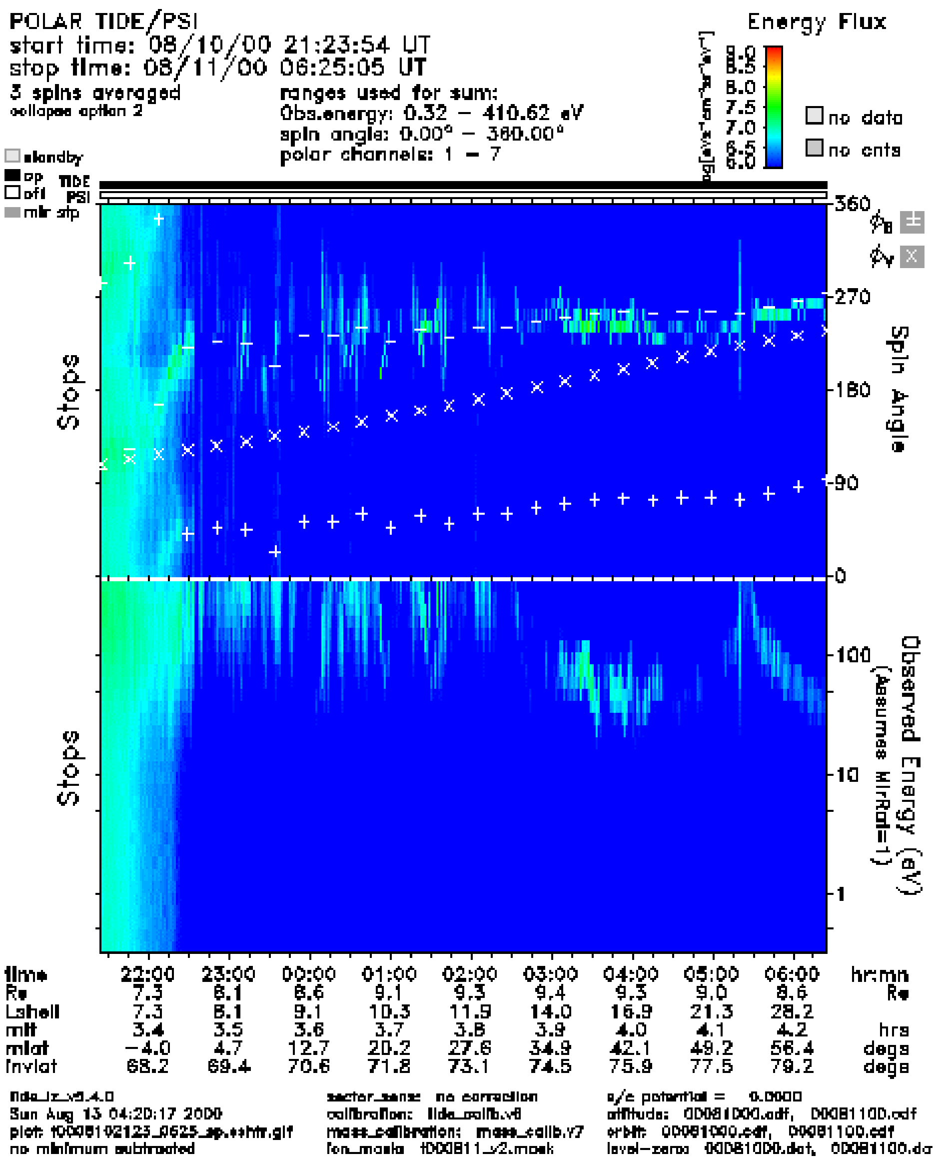
Low-Energy Ion Beams:

Simulations of Their Transport Through the Inner Magnetosphere

Motivation

"Lobal winds" in the TIDE data



Lobal winds are ...

... ubiquitous

Seen by Polar-TIDE throughout nightside apogee passes

See by LANL/MPA as an "ion line" when S/C charging is large and negative (0-6 LT)

... low-energy ion beams

Highly field-aligned

~100 eV of drift energy

< 10 eV of thermal energy

Densities are small, < 1 cm^{-3}

... probably O^+

Test particle modeling shows thats the only possible species

Eminating from the nightside auroral zone (?)

... directed Earthward during substorm dipolarizations

One case showed no acceleration, heating, or isotropization

Split energy peaks during this event could be H^+/O^+ filtration (?)

... probably captured into the plasma sheet

Test particle modeling shows PS entry for X < -20 R_E

Also shows > 10x energy increase and isotropization upon entry

Also show that near-earth PS crossings are not usually "captured"

Question

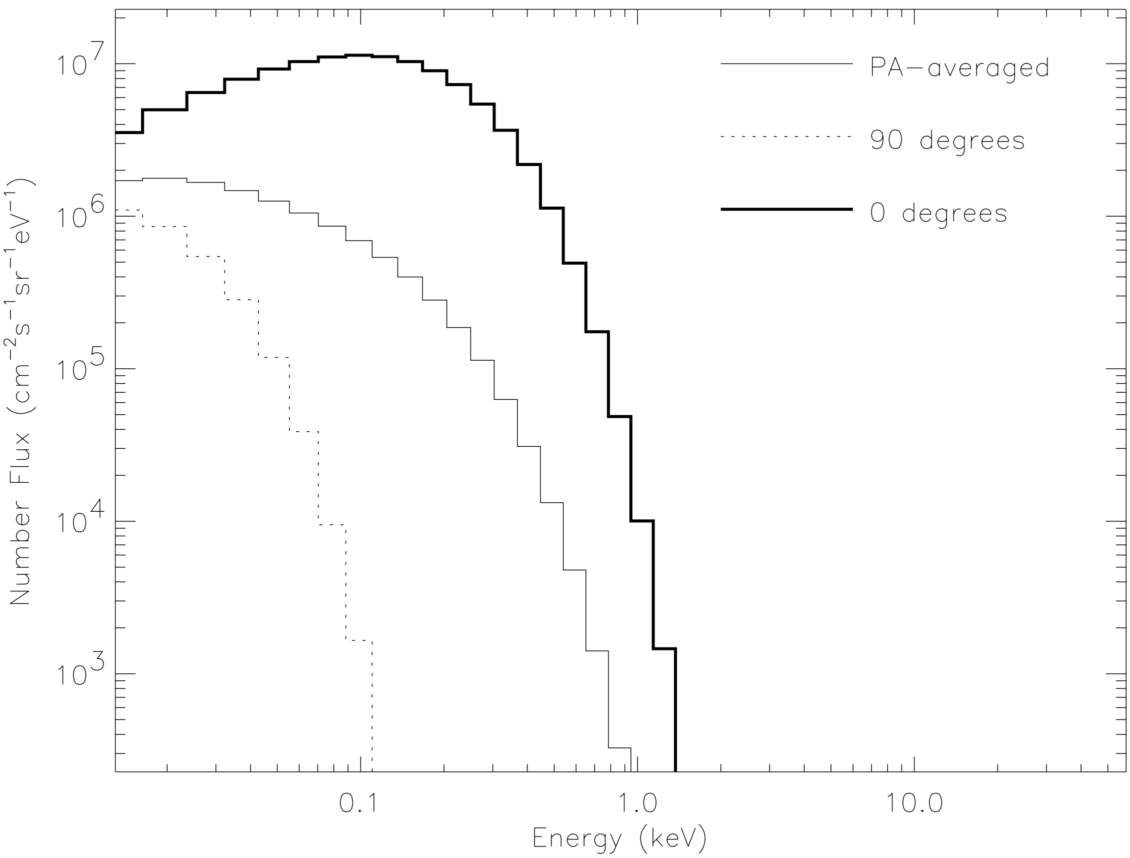
How would these low-energy ion beams (LEIBs) move through the inner magnetosphere?

Answer

Run some numerical experiments with different LEIBs and different convection patterns

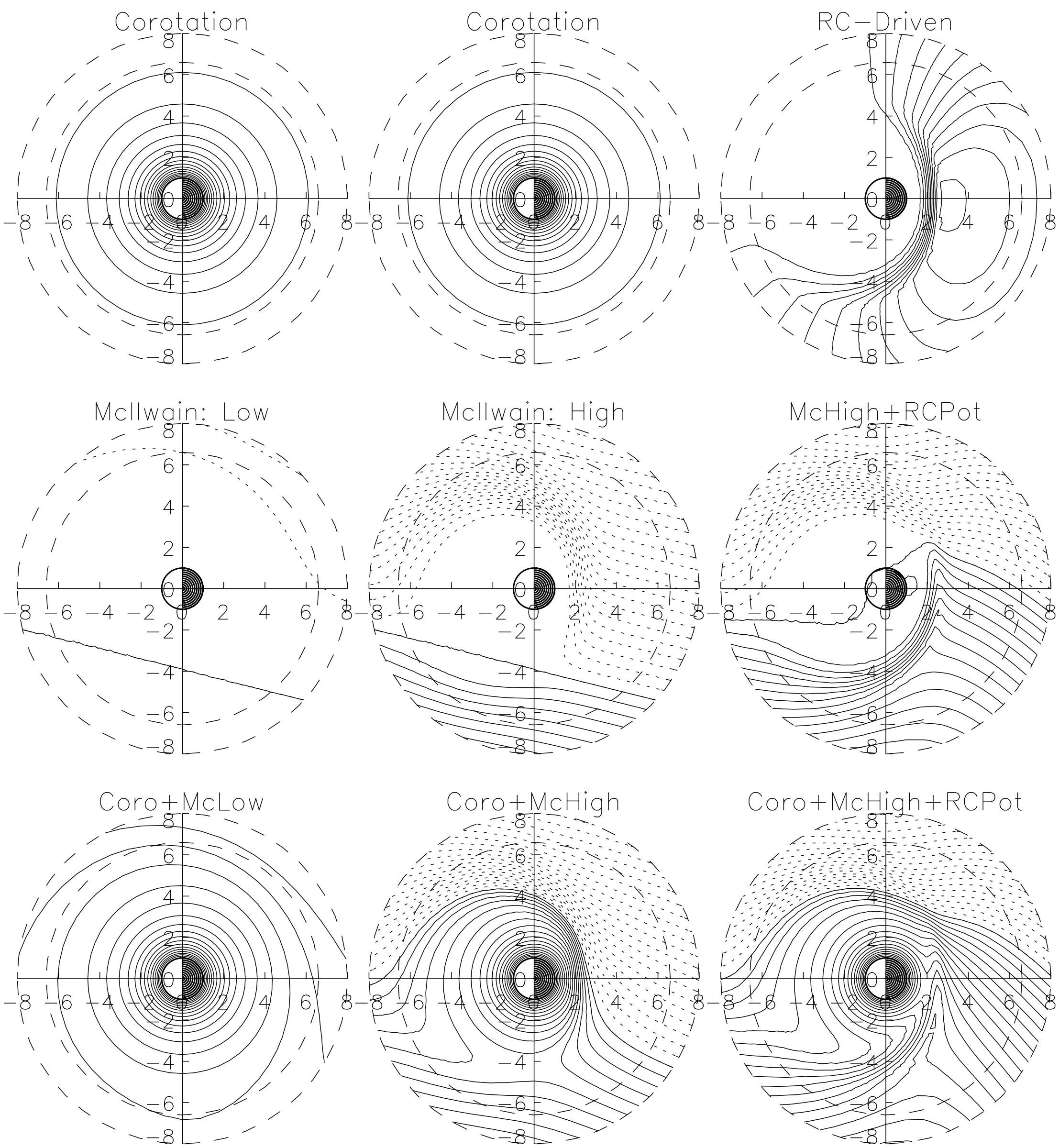
Boundary Conditions

Density of 1 cm^{-3} with $T_{\parallel}$=100 eV and $T_{\perp}$=10 eV

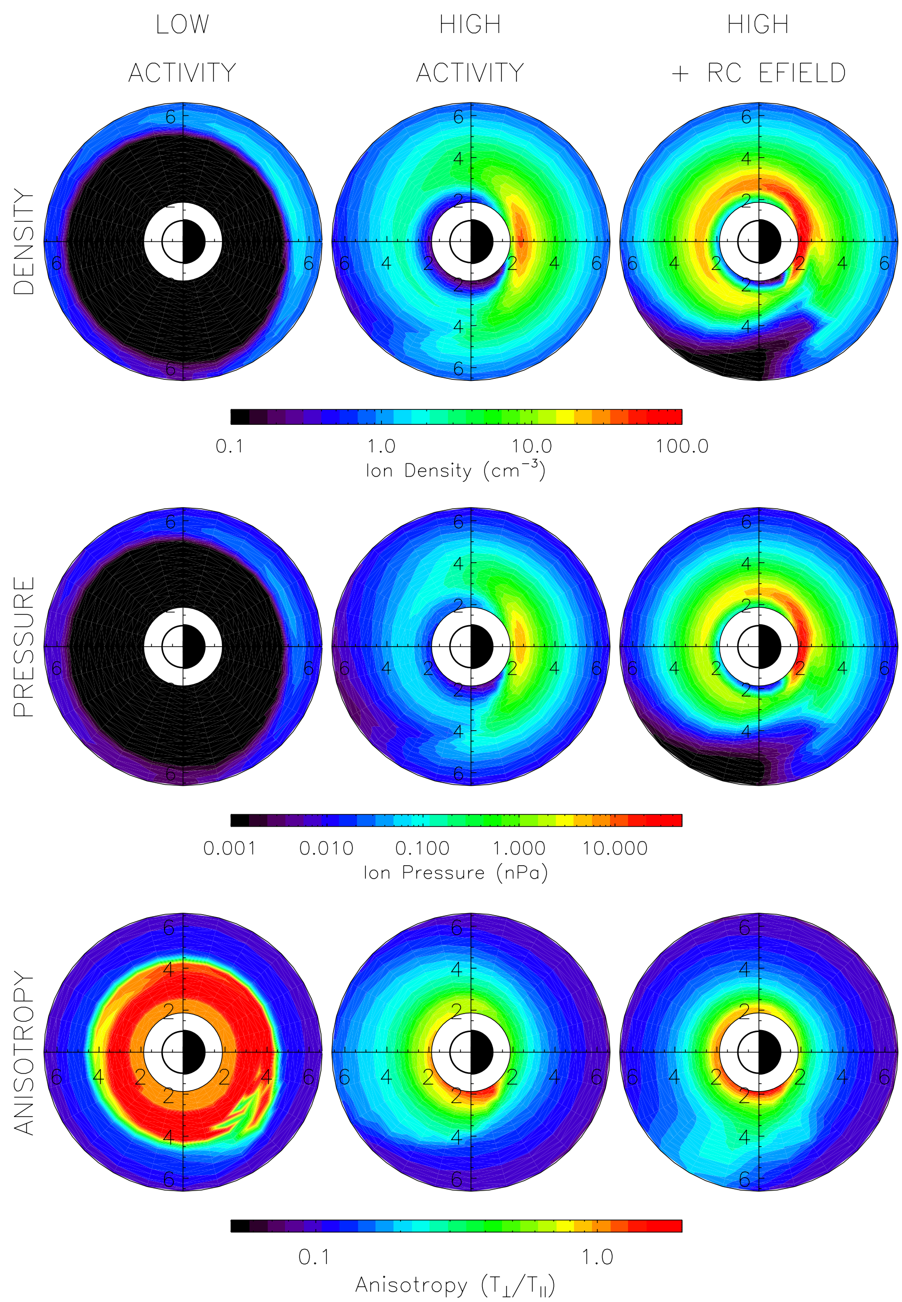


Convection Patterns

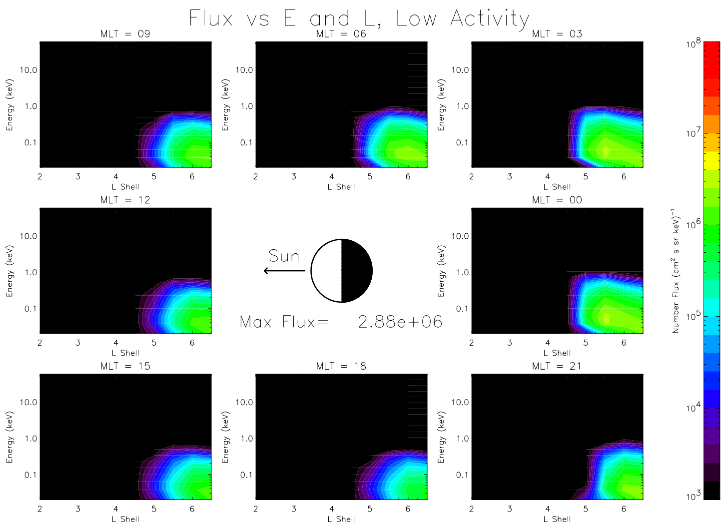
"Low Activity" Simulation: Kp=2, $\Delta\Phi_{PC}$=40 kV
"High Activity" Simulation: Kp=9, $\Delta\Phi_{PC}$=200 kV
"High + RC EField" Simulation: Kp=9, $\Delta\Phi_{PC}$=200 kV, plus $\Delta\Phi_{RC}$=55 kV
Contours every 5 kV, dotted is > 0 and solid is < 0

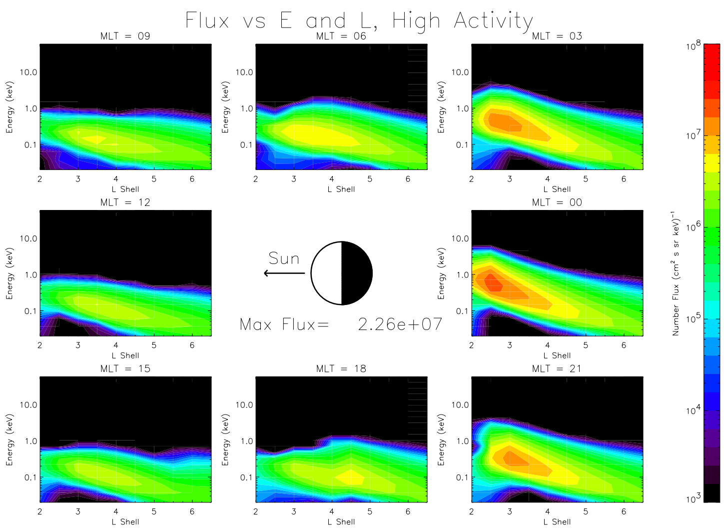


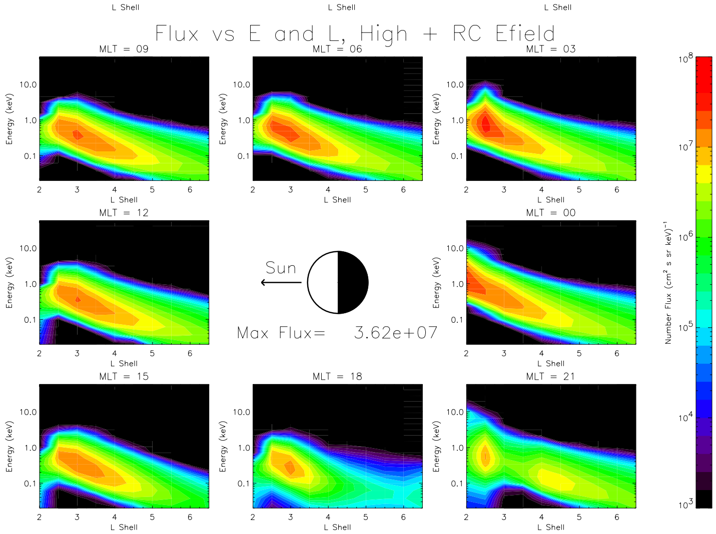
Global Dial-Plot Results



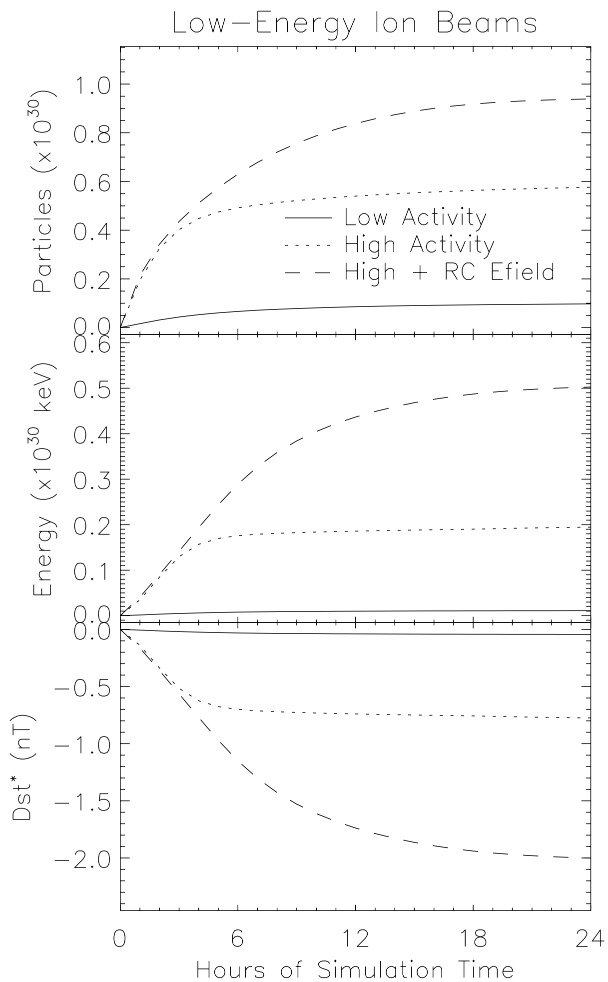
Pitch-Angle Averaged Fluxes







Total Content Quantities



Activity Level	Ntot (24 h) [ions]	Etot (24 h) [keV]	Dst (24 h) [nT]	Etot/Ntot [keV/ion]	t(90% Etot) [hours]
Low	9.75×10^{28}	1.10×10^{28}	-0.0439	0.113	12
High	5.77×10^{29}	1.95×10^{29}	-0.775	0.338	5
High+RC	9.39×10^{29}	5.03×10^{29}	-2.00	0.535	13

Ratios:

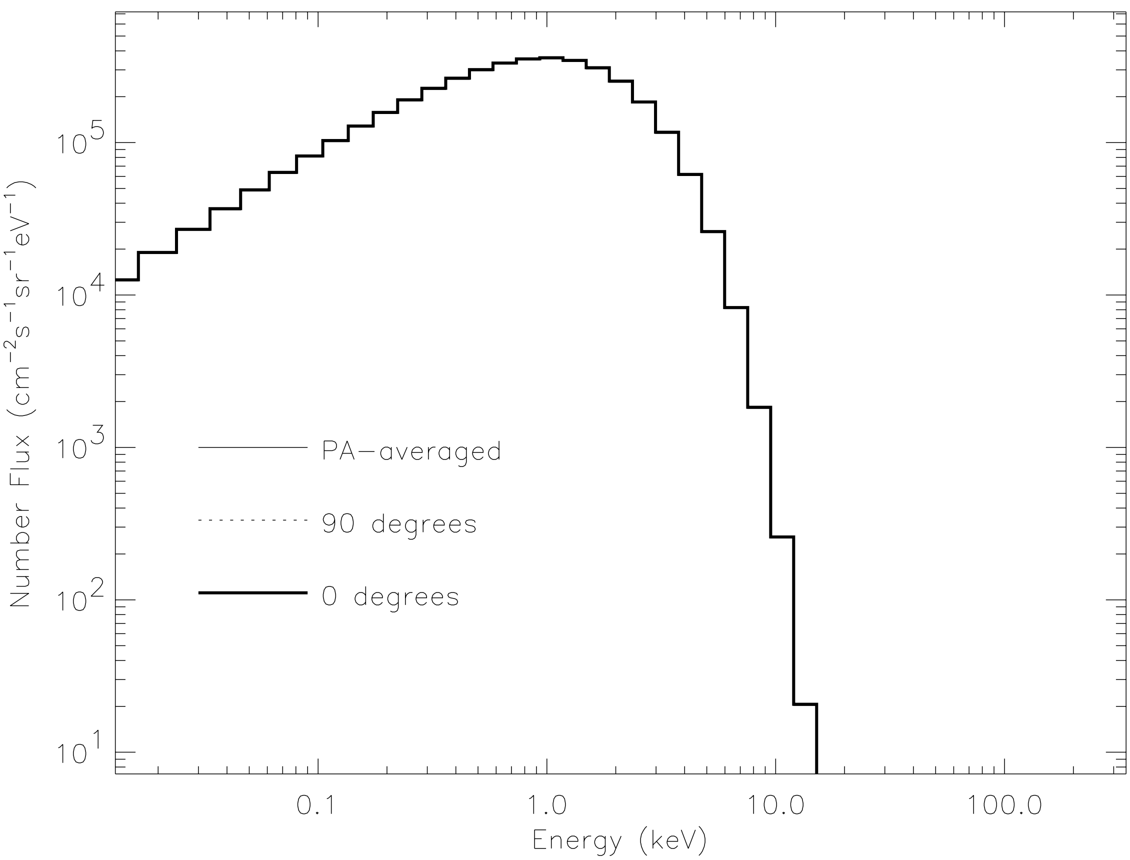
Etot (high+RC) / Etot (low)	45.5
Etot (high+RC) / Etot (high)	2.58
Etot (high) / Etot (low)	17.6

Another Test:

LEIB After Plasma-Sheet Capture and Acceleration

Boundary Conditions

Density of 1 cm^{-3} with $T_{\parallel}$=1 keV and $T_{\perp}$=1 keV



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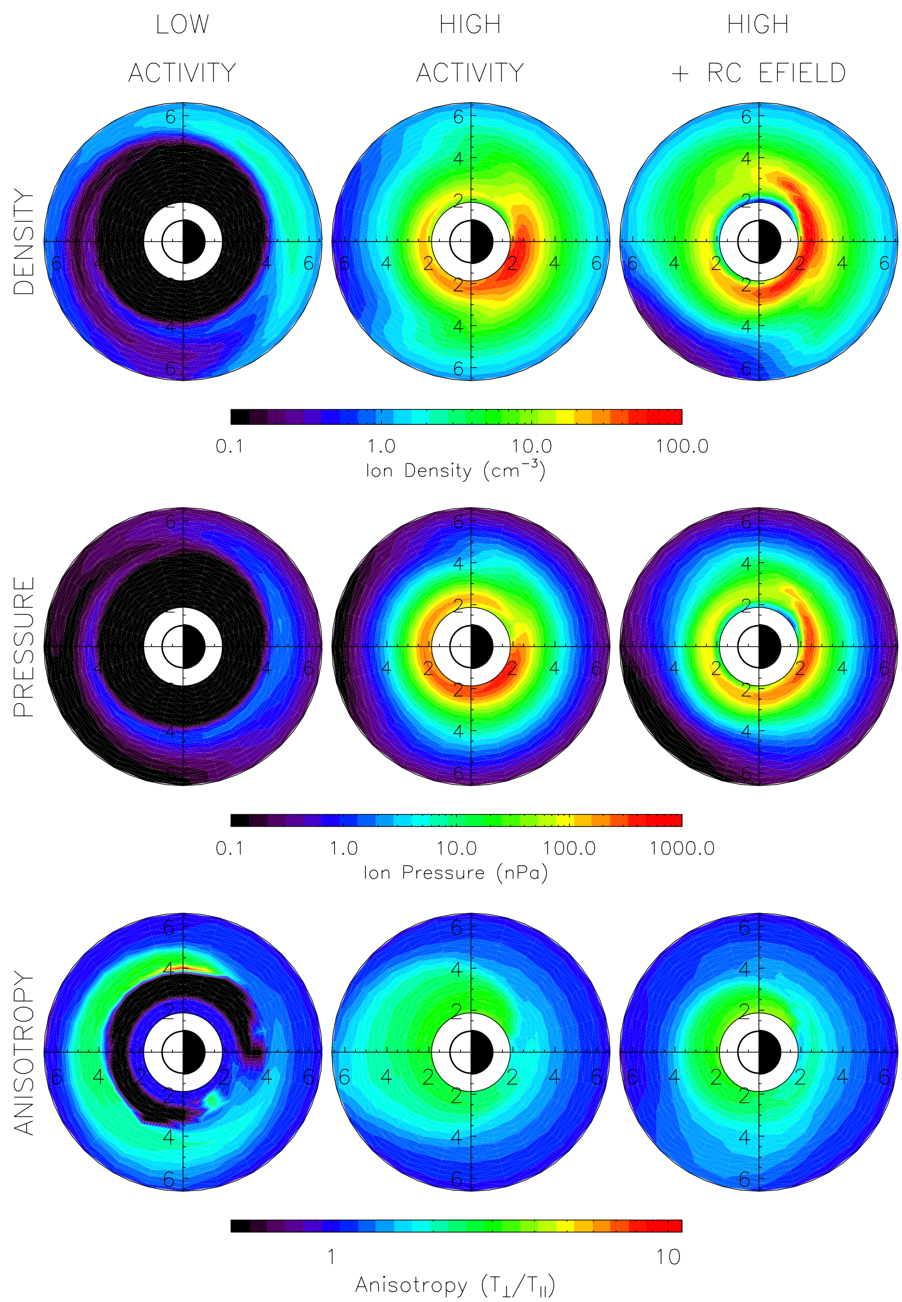
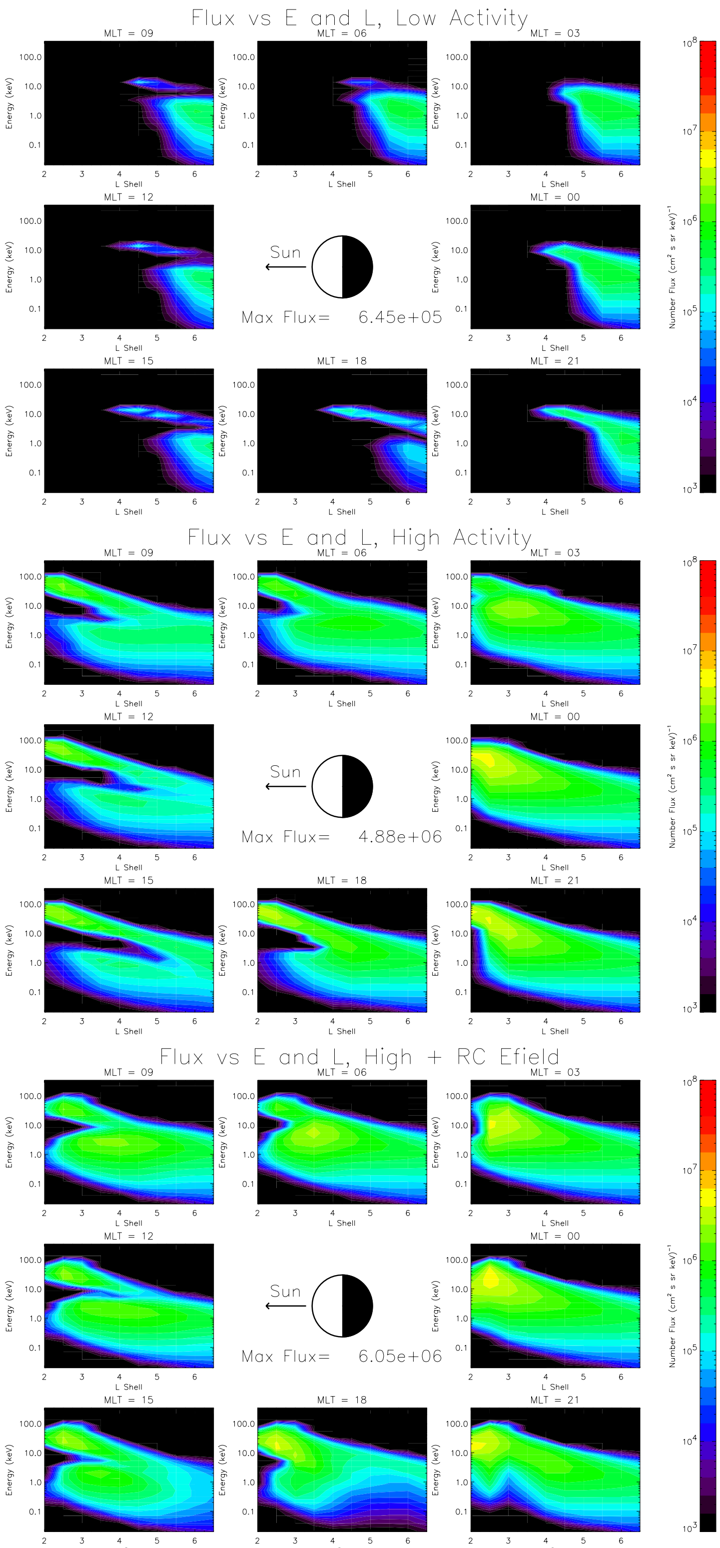


Pitch-Angle Averaged Fluxes



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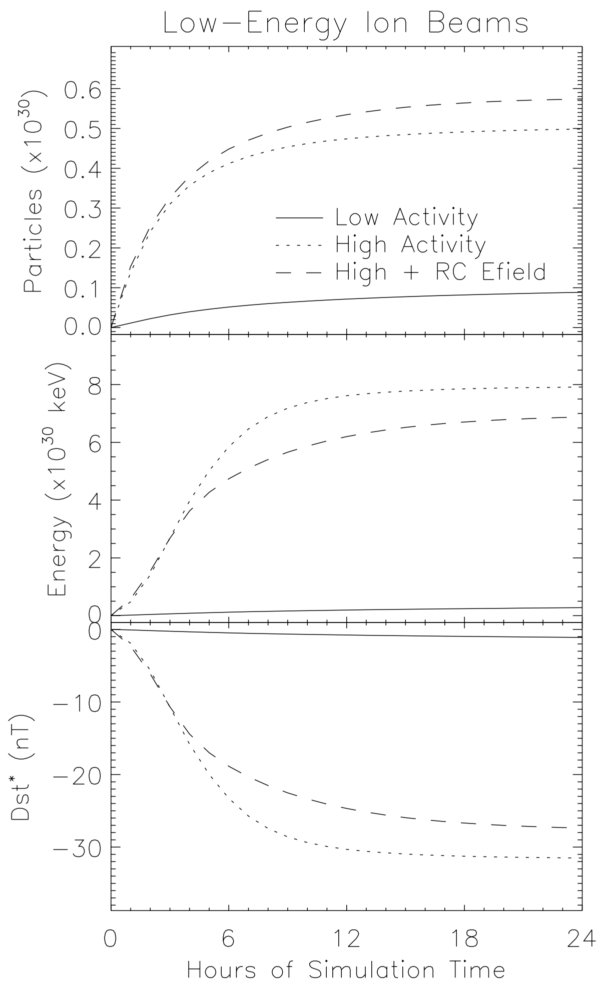

Activity Level	Ntot (24 h) [ions]	Etot (24 h) [keV]	Dst (24 h) [nT]	Etot/Ntot [keV/ion]	t(90% Etot) [hours]
Low	$8.86\text{x}10^{28}$	$2.78\text{x}10^{29}$	-1.11	3.14	19
High	$4.98\text{x}10^{29}$	$7.91\text{x}10^{30}$	-31.5	15.9	8
High+RC	$5.74\text{x}10^{29}$	$6.88\text{x}10^{30}$	-27.4	12.0	11

Ratios:

Etot (high+RC) / Etot (low)	24.7
Etot (high+RC) / Etot (high)	0.869
Etot (high) / Etot (low)	28.5